Chapter 13
Power Supply

13-1. General

When the power requirements for the pumping station have been tentatively established, the adequacy of the intended source of electrical power and any limitations of that source must be determined before proceeding with station design (Plate 10). The design investigations should disclose the optimum system operating voltage, capacities, and location of existing utility facilities which may be involved in the supply of power to the pumping station, supply system reliability, voltage regulation, inrush current limitations, power factor restrictions, and short circuit characteristics. The Electric Power System Data Sheet in Appendix G is a convenient means to organize the information received.

13-2. Station Operating Voltage

It is extremely important that the proper operating voltage for the motors be selected, if the minimum overall installed cost of equipment is to be realized. Most flood-control pump stations operate at either 480 or 4,160 volts. As a general rule-of-thumb, motors of 150 kW (200 HP) and below are usually most economically operated at 480 volts. Above 150 kW (200 HP), 2,300- or 4,000-volt motors should be considered. Once the station capacity has been determined, the utility should be contacted to determine what utilization voltages are available. The utility rate structure and discounts such as untransformed service credit must also be obtained and analyzed. Determination of the most economical operating voltage requires accurate estimation and comparison of the complete electrical installation costs required for each operating voltage considered. Costs which must be considered include line construction, substation installation, motors, controls, conduit/cable sizes, and floor space required.

13-3. Power Supply Reliability and Availability

a. General. The first step in assuring an adequate power supply to a pumping station is to define the degree of reliability needed. This is not an easy task that results in the assignment of a numerical value. It is, instead, an evaluation of the tolerable power outages versus the additional costs to reduce the probability of outages. Some factors to consider in determining the degree of reliability needed in the power supply are:

(1) The type of property being protected. Is it cropland, industrial plants, or urban areas?

(2) The consequences if the pumping station fails to operate when required. Would an industrial plant be inundated causing immediate damage or could crops planted in a rural area tolerate submergence for a short time? Is ponding available? Would residential areas be flooded? Could there be potential human injury?

(3) The frequency and duration of outages that are acceptable to prevent any of the above.

(4) The time of year flooding is likely to occur. Does that pose any special problems such as overloading total utility capabilities?

Once the designer has established a feel for the need of continuity of service, contact with the utility is necessary to establish a system to meet that need. Several meetings or correspondences may be required to work out final details of the system. Chart G-1 of Appendix G is a flowchart for interfacing with the power company.

b. Availability. Availability could be defined as the long-term average that the electric service is expected to be energized. Outage data, given over a 5-year period, are usually available from the utility. The number of outages and duration of those outages over the 5-year period for the substation which will supply the pumping station can be used to calculate the availability.

c. Distribution system alternatives. Plate 11A depicts the functional components of a typical electric power system. The pumping station designer will primarily be concerned with subtransmission and distribution systems when discussing reliability considerations with the utility. Basically, there are two types of distribution systems:

(1) Radial.

(2) Network.

A radial system has only one simultaneous path of power flow to the load; a network has more than one simultaneous path of power flow to the load. A complete listing of the variations of these two broad groups falls outside the scope of this document. For an in-depth description of the various configurations, consult *Electric Utility Engineering Reference Book--Distribution Systems* by the Westinghouse Electric Corporation (1980). Plate 11B indicates some of the more commonly used distribution system configurations. Beginning at the top left of the drawing with the network primary feeder, the system's reliability increases as one moves clockwise around the loop. In general, the usage of a radial feed should be limited to projects where either the economics or characteristics of the protected property do not justify or require a more expensive network. Not all of the network schemes shown will be available from every utility. Consultation with each utility will be necessary to provide the appropriate system for the particular application.

13-4. Pumping Station Distribution Substation

a. Layout and design. Normally the Government contracts with the local utility to design, construct, operate, and maintain the power supply to the pump station. In some cases, the electric utility will ask the Government to provide the transformer pad as part of the pumping station contract. In such cases, close coordination between the utility, the Government, and the contractor will be necessary to ensure pad sizes, and mounting bolt locations are as required by the utility's transformers or other substation equipment. The substation should be located as close to the pumping station as possible. Further guidance on rights-of-way, ownership, operation, etc., of the transmission line and substation may be found in TM 5-811-1, Electric Power Supply and Distribution.

b. Transformers. The type of transformer used, i.e., whether single-phase or three-phase, should generally be determined by the availability of replacements from the local power company stock. Most utilities keep an inventory of replacement transformers of the various sizes necessary to provide quick replacement. The designer should inquire as to the location of transformer storage and the length of time required to transport and install it in an emergency. All transformers used must be non-PCB to comply with all Federal, State, and local laws. It is common in rural areas to employ three single-phase transformers connected either wye-delta or delta-delta so that, in the event of a transformer failure, they can remain in operation when connected in an open-delta configuration. However, this configuration should be used with caution since it prohibits the application of ground fault relaying as well as producing inherent unbalanced voltages which could result in the overloading of motors. Another, more attractive, option would be the furnishing of a fourth single-phase transformer or a second three-phase transformer as a spare.

13-5. Supply System Characteristics

An interchange of information between the designer and the utility is necessary if the pumping station electrical system is to be compatible with the power supply furnished. The designer should obtain the data requested in Appendix G from the local utility supplying power to the proposed pump station. To prepare the short-circuit studies indicated in Paragraph 23-3, the designer will need to obtain the maximum fault current available from the utility as well as information concerning the distribution substation transformer impedance. The designer should transmit station loads and motor starting requirements to the local utility as soon as they become available so that the utility can prepare an analysis of the impact upon their system. The utility can then advise the designer of power factor and motor inrush current limitations. After details of the electrical system have been coordinated, the designer should request time-current curves of the substation primary side protective devices so that a coordination study as described in Paragraph 23-2 can be prepared.

13-6. Pumping Station Main Disconnecting Equipment

For guidance on selection of the pumping station main disconnecting equipment, see Paragraph 15-2.